8 Groundwater Investigation Results

This section presents the results of the groundwater investigation that was performed for the Supplemental RI and analyzes the results together with the initial RI data to refine the known details of the LNAPL plume and groundwater chemistry. Groundwater samples were collected during the Supplemental RI from selected wells in accordance with the Supplemental RI/FS Work Plan (RETEC, 2001a) between January 15 and January 18, 2002. This was the first of two semiannual sampling events; the second is currently scheduled for July 2002. Details of the groundwater sampling methods are provided in Section 3.6 of this Supplemental RI Report. The groundwater samples were submitted for total petroleum hydrocarbons and selected samples were also submitted for PAHs, BTEX, and/or EPH/VPH. In addition, one sample was submitted for PCB analyses. The wells sampled and parameters analyzed are provided in Table 3-8. LNAPL on the groundwater, where present, was also measured and that data are evaluated in this section.

8.1 Petroleum Hydrocarbons

During the Supplemental RI sampling event (January 2002), groundwater from 50 site wells was analyzed for TPH using Method NWTPH-Dx (extended range analysis). The NWTPH-D analysis tests for the common diesel carbon range (C9 to C24). The NWTPH-Dx analysis was performed to include heavier hydrocarbons that could be associated with bunker C releases at the former maintenance and fueling facility. Unlike gasoline or diesel, bunker C does not have a specified carbon range. Hydrocarbon identification (HCIC) analyses performed in January 1994 on various hydrocarbon samples obtained from the site were reported in the Draft RI Report. This analysis shows that NWTPH-Dx analyses are sufficient to detect and quantify the bunker C oil associated with the former maintenance and fueling facility.

8.1.1 LNAPL Distribution

The hydrocarbons (predominantly diesel and bunker C) present within the site may be present as (i) free-phase LNAPL (light non-aqueous phase liquid) (synonymous with free/free-flowing/mobile LNAPL), (ii) residual LNAPL, and (iii) dissolved-phase constituents. Free-phase LNAPL is an oily liquid that floats on groundwater and accumulates on top of water in wells. Areas of free-phase LNAPL are areas where LNAPL will flow through the subsurface sand and gravel. Residual LNAPL is an oily residue that is trapped in the soil pores due to capillary pressure following the removal of mobile LNAPL or migration of mobile LNAPL out of the soil material. Residual product is generally found in source areas and the zone of groundwater table fluctuation (smear zone) surrounding areas of free-phase LNAPL. Areas of residual product are characterized by elevated concentrations of total petroleum hydrocarbons (TPH), and an oil sheen or isolated bodies of LNAPL on the soil materials. Residual LNAPL can provide a continuous source of contamination to groundwater from soluble constituents. Dissolved-phase constituents include chemicals such as naphthalene; these are constituents of LNAPL and dissolve into groundwater from the free-phase or residual phase LNAPL over time. Figure 8-1 shows these three modes of hydrocarbon occurrence and the conceptual relationship between them.

During the Supplemental RI field investigation, wells were evaluated for LNAPL and information on the thickness and occurrence of free-phase product in wells was collected. Product presence and thicknesses were recorded during the initial RI fieldwork and the Draft RI Report concluded that the LNAPL plume was relatively stable although the product thickness at specific locations varied slightly from one gauging event to another. The Draft RI Report also concluded that, in some wells, product was noted on an intermittent basis and these areas were identified as residual product only.

The Draft RI Report (RETEC, 1996a) concluded that there were three areas of free-phase product. One product area extended from the former maintenance and fueling facility to the north-northwest towards the river. Product seepage along a portion of the riverbank was observed under low river stage in the late fall at locations consistent with free product in wells. The second product area was located in the vicinity of MW-39 in the southern part of the rail yard near a former oil pump house. The third product area was located in the vicinity of wells MW-11 and MW-17 in the southeast portion of the rail yard near the former engine house.

The extent of the LNAPL plume has been re-evaluated for this Supplemental RI Report. A site-wide fluid gauging event was conducted in January and February 2002 for the Supplemental RI investigation. This fluid gauging event included all existing and all new wells. As a result of this, the number of gauging stations increased and the extent of free product has been better defined. The fluid gauging measurements from this gauging event are provided in Table 6-1, and are presented in Figure 8-2.

Most of the new wells were screened so that the water table lies within the screened interval of the well. However, 2B-W-4, 5-W-1, 5-W-2, 5-W-3 and 5-W-4 were all screened below the water table.

These wells were constructed with the screens below the water table to accommodate a cement seal that protects the wells from frost heave. Prevention of frost heave was a priority for the Town of Skykomish because these wells are located in a public right-of-way that is plowed on a regular basis. In the higher elevations, such as Skykomish in which the ground may undergo repeated cycles of freezing and thawing, frost heave on wells can be a problem. The effect of frost heave would be to lift the wells slightly from their current positions, so that the wells would be raised slightly above the ground surface. This could lead to damage to both the wells and the snow plow blade during plowing. To prevent the effects of frost heave, the wells should be constructed such that their cement seals extend past the depth affected by freeze-thaw cycles. This requires that the cement seals extend to a minimum depth of four feet. Below the concrete seal, a watertight bentonite seal is required of at least one foot. Standard well construction methods also require one to two feet of sand pack above the screen. Therefore, in these five wells, screens were placed at least six and a half feet bgs (4 feet cement seal, 1 foot bentonite, and 1.5 feet sand pack).

In January 2002, the water table was very shallow and it is expected that all new wells will intercept the water table at least part of the year, allowing detection of LNAPL, if present. Fluid levels within these wells have been gauged monthly since installation and will continue to be gauged on a regular (at least quarterly) basis, for the next two years. The fluid levels will be compared to the screened intervals to assess whether the well screens intercept the water table for at least part of the year, and can allow detection of LNAPL if present.[1] If the wells do not screen across the water table, additional groundwater samples may be collected and analyzed to determine whether free-phase LNAPL could potentially be present in the wells. If the chemical data indicate that free-phase LNAPL could be present in the wells and is being screened out of the well, then the wells will be considered for replacement.

Based on the current dissolved TPH data for these five wells, 2B-W-4 is not likely to contain LNAPL since no TPH was detected above the detection limit in groundwater samples and smear zone soil samples had very low detected TPH concentrations (7.4 mg/kg TPH as diesel and 33 mg/kg TPH as motor oil). Wells 5-W-1 and 5-W-3 were not sampled for groundwater, as they were believed to be contained within the LNAPL plume boundary. The smear zone soil data for these borings confirms the presence of at least high residual TPH, if not LNAPL (6,400 and 21,200 mg/kg total TPH, respectively).

5-W-2, in addition to having detectable LNAPL in the well, also had 1.2 mg/L TPH as diesel in groundwater. Based on these data, 5-W-2 and 5-W-3 appear to be in the LNAPL plume as shown in Figure 8-2. 5-W-4 contained 26,000 mg/kg total-TPH in a soil sample collected from the smear zone, and 0.42 mg/L of TPH as diesel in groundwater. Groundwater samples from the other wells throughout the site indicate that wells containing less than 0.5 mg/L TPH as diesel do not contain free-phase LNAPL. Therefore, 5-W-4 may not contain free-phase LNAPL, but does contain high residual concentrations of LNAPL.

Note that free product was measured in 5-W-2 and 5-W-3 in January 2002 even through they were screened below the water table at the time. This

[1] LNAPL has been detected in 5-W-2 and 5-W-3 even though the well screens did not intercept the water table at the time of gauging. However, the accuracy of the measured product thicknesses is unknown.

observation may be explained by the fact that the LNAPL found at the site has a specific gravity of almost 1.0 (or near that of water). This may result in LNAPL to occur distributed across the upper portion of the water table rather than a layer floating entirely on the water surface (see Figure 8-1).

Figure 8-2 shows the estimated extent and thickness of free product throughout the site based on the January 2002 measurements. These measurements indicate that the areal extent of the LNAPL plume may have been significantly overestimated in previous investigations using fewer data points. The January 2002 measurements indicate that, instead of one continuous LNAPL "plume" extending from the rail yard towards the Skykomish River, the LNAPL is present in several smaller, discontinuous plumes within the same general area as the previously defined, single plume. Between these areas of free product are areas of residual product. The "apparent" thickness of the LNAPL is as great as four feet (in well MW-36); however, it tends to have an average thickness of approximately 0.5 foot.

It should be remembered that Figure 8-2 presents the observations made during a single sampling event, and that the extent of free LNAPL can vary from one event to another. An additional site-wide fluid gauging event will take place during the seasonal low groundwater elevation in summer 2002, and differences in the extent and thicknesses of LNAPL will be evaluated. Furthermore, all wells that have formerly contained free LNAPL, or that currently contain LNAPL, are located near the free-LNAPL plume and will be gauged at least quarterly to verify observed changes in extent over time.

In addition to the January 2002 fluid gauging data, the geologic and lithologic information from all wells and boreholes outside the plume areas shown on Figure 8-2 were reviewed. This information, which is qualitative rather than quantitative, indicates that boring logs near the plume describe "product" in the saturated zone even though the wells subsequently do not contain "free product." The boring logs are more likely describing "residual product" in the smear zone, but below the water table at the time the borings were installed, rather than "free product" that will flow into wells over time.

A comparison of Figure 8-2 with Figures 7-5 and 7-6 (TPH in Smear Zone Soil) indicates that the plume locations do not always coincide with the locations containing highest TPH concentrations in the smear zone soil. Most significantly, many soil samples on the rail yard contained high TPH concentrations in the smear zone but no product in the wells. This implies that the soil contamination in these areas is a result of residual TPH in the soil rather than free-phase LNAPL.

Figure 8-2 presents the product thickness data collected during the site-wide gauging event for the Supplemental RI, and these data are used to prepare the free product thickness contours shown on the figure. In addition, visual observations recorded on boring logs have been summarized on the figure, as described below:

1) Wells shown in gray contained no evidence of soil contamination during drilling.

2) Wells shown in black contain evidence of soil contamination in the smear zone; however, no product was recorded in these wells during gauging.

3) Wells shown in blue contained recorded observations of product in the drill cuttings from the smear zone. The product may have been free or residual at the time of logging; however, during the gauging event, the wells with observed product that contained no LNAPL are assumed to have residual product rather than free product in the smear zone.

4) Wells shown in red contained evidence of soil contamination in the vadose zone. This indicates a potential source area where hydrocarbons migrated vertically through the unsaturated vadose zone from the surface rather than being transported laterally by groundwater flow in the smear zone.

A subsurface barrier wall was installed along the Skykomish River during fall 2001 to minimize LNAPL seeping into the Skykomish River. Specific fluid level data (not presented in this Supplemental RI) are being collected to assess the performance of the wall. However, the data collected for the Supplemental RI indicates that the barrier wall was not creating a mounding of product behind the wall in January 2002.

The interpretation of the most recent LNAPL data is very different from the interpretation of data in the Draft RI Report. However, in light of the new data, the current interpretation is consistent with the historic data. Figure 8-3 compares the extent of free-phase LNAPL as defined by the January 2002 data collected for the Supplemental RI with the location of free-phase LNAPL during five monitoring events since 1993 (November 1993, April 1994, August 1994, November 1994, and November 2000). Each monitoring event is shown as an individual inset on Figure 8-3, with the wells that contained product during each respective historic gauging event shown in red, the wells that contained free-phase LNAPL during the January 2002 gauging event shown in blue, and the wells that contained free-LNAPL in both the historic event and during January 2002 shown in green.

In November 1993, the following wells contained free-phase LNAPL product: MW-6, MW-8, MW-15, MW-17, MW-20, MW-21, MW-22, MW-25, MW-27, and MW-39. Monitor wells MW-29, MW-21 and MW-25 contained free-phase LNAPL in January 2002, however no free LNAPL was present in any of the other wells that contained free LNAPL in November 1993. In addition, free LNAPL was not present in any wells that were gauged in November 1993 that did not contain free LNAPL at that time, and LNAPL had not migrated into any new areas that did not contain free LNAPL in November 1993. This indicates that much of the LNAPL that was present in the railyard is no longer there. The soil data indicates that there may be high residual LNAPL concentrations in the railyard, and therefore it appears that the free LNAPL formerly present on the railyard has either attenuated or migrated to the northwest to its present location. Observations made during drilling additional boreholes and wells for the Supplemental RI show that the residual LNAPL on the railyard is highly viscous and immobile in most cases, and suggests that the saturation concentration of residual LNAPL may be high.

The free-phase LNAPL in the monitoring wells showed a similar distribution to November 1993 in April and August 1994. However by November 1994, free-phase LNAPL had appeared in MW-36, suggesting that the free-phase LNAPL had continued to migrate to the northwest from the railyard. This is consistent with one of the implications from the observed differences between free-phase LNAPL distribution between November 1993 and January 2002, that the free-phase LNAPL has been migrating to the northwest (towards the barrier wall) from the railyard. There is more evidence for LNAPL migration or attenuation from the November 2000 gauging event. This event indicates that several of the wells that previously contained free-phase LNAPL (MW-39, MW-6, MW-28) no longer contain free LNAPL. Furthermore, by January 2002 free LNAPL was no longer present in MW-8 and MW-27. Previous measurements indicate that MW-27 contained more than three feet of free LNAPL in March 2001. However, more recent measurements show decreasing thicknesses of free LNAPL accumulations (1.2 feet on October 31, 2001, zero feet on February 7, 2002, and 0.1 foot on March 8, 2002). This well will continue to be gauged at least quarterly to assess continuing trends in LNAPL accumulation.

The data presented in Figure 8-3 indicates that the extent of free LNAPL was formerly more extensive throughout the site than at present, and that free LNAPL was present throughout much of the railyard. The extent of free LNAPL is now greatly reduced according to the gauging data collected in January 2002. The reduction in extent could be influenced by or due to the following factors:

1) Migration off the railyard towards the river. This has occurred in the past as evidenced by the presence of LNAPL downgradient from the railyard (source area) and as seeps in the Skykomish River.

2) Attenuation of free-phase LNAPL without significant migration. The evidence for this is that free LNAPL has not accumulated in any new upland areas downgradient from wells that formerly contained free LNAPL but no longer contain any.

3) Attenuation of free-phase LNAPL in combination with migration. This is probably actually causing the reduction in free-phase LNAPL. Even where LNAPL was formerly observed and is no longer present, and where free LNAPL has not accumulated in formerly unimpacted downgradient wells, migration may have occurred. However, as the free-LNAPL migrates into new areas, the saturation concentration rapidly decreases to residual concentrations rendering the free LNAPL immobile and unable to flow into wells. Therefore, although the volume of free-phase LNAPL may be decreasing, the volume of residual LNAPL may be increasing.

4) The LNAPL has been observed to have high viscosity and therefore, it is possible that the well screens for some of the pre-Supplemental RI wells may have partially or completely become clogged, thus reducing or preventing the inflow of LNAPL.

5) The estimates of LNAPL extent may have been influenced by difficulties in measuring the product thickness. Historically, the high viscosity of the product has resulted in difficulties in measuring the product thickness. Therefore, product thicknesses have not been consistently recorded and thicknesses that were recorded may have contained inaccuracies due to the limitations of conventional methods used to determine product thickness. The recent measurement techniques (1999 to present) provide more reliable measurements of product thickness in wells.

In well MW-27, free product has generally been observed during previous gauging events yet none was observed during the January 2002 fluid gauging. The reason for this change is unknown; however, further gauging will be performed to establish whether product accumulates in that well again. The observed variability of product occurrence and thickness in MW-27 can be related to various factors including the elevation of the water table and whether the water table is rising or falling at the time of measurement.

The dissolved concentrations (Section 8.1.2) of hydrocarbons are also consistent with the current interpretation of the areal extent of LNAPL. The initial RI data indicated that TPH concentrations are closely correlated with areas of free product, and that TPH concentrations only exceed 1.0 mg/L in wells where free product has been reported. This can be seen in the Draft RI figures, which show LNAPL and dissolved plumes that are effectively co-extensive. The Supplemental RI data, however, show that TPH concentrations greater than 1.0 mg/L are present in wells that do not contain free product. The boring logs show that most of these wells contain residual product or staining in the smear zone. It is reasonable to conclude that residual product also results in concentrations of dissolved TPH in groundwater greater than 1.0 mg/L. A complete discussion of nature and extent of dissolved-phase TPH is contained in Section 8.1.2.

The free product, or LNAPL, volume has been re-estimated in light of the supplemental data. The total area of the LNAPL plumes shown in Figure 8-2 is 88,400 square feet. Assuming an average LNAPL thickness of 0.5 feet in the west plume, one foot in the east plume, and 0.3 feet in the smaller plumes, a total porosity of 30 percent and product saturation of 50 percent, it is estimated that 60,000 gallons of free product are present at the Site. Note that of this estimated 60,000 gallons, only a small percentage is likely recoverable. Similarly, the LNAPL volume between the barrier wall and the river has been estimated assuming a total area of LNAPL of 19,000 square feet (based on extension of plumes to the river and observed seep locations), and average LNAPL thickness of 0.5 feet, and a total porosity of 20 percent[2] with 50 percent product saturation. The volume of free product beneath the levee is estimated to be 7,000 gallons. Note that of this 7,000 gallons, only a small percentage is likely recoverable. Note also that “free product” and “LNAPL” are synonymous, and these terms are different than “residual product” or small isolated “droplets of product.”

8.1.2 Dissolved Contaminant Distribution

Total Petroleum Hydrocarbons

During the Supplemental RI, groundwater samples were collected from 50 wells in January 2002 and the samples were analyzed for TPH using Method MWTPH-Dx (extended range analysis). Groundwater samples will also be collected from these wells during the second semiannual sampling event planned for July 2002. During this summer sampling event, five wells (1A-W-1, 1A-W-2, 1B-W-1, 2A-W-2, and MW-27) that were not sampled during January 2002 should also be sampled. These five were assumed to be in the area of free product and would not have been representative of dissolved concentrations. However, as discussed in Section 8.1.1 above, no free product has been observed, and none is expected, in these wells. The dissolved concentrations from these wells should be representative and should be analyzed in the next round of sampling.

TPH concentrations in groundwater for the Supplemental RI sampling event are presented in Table 8-1. The TPH has been divided into diesel-range and motor oil-range hydrocarbons. The data show that motor oil-range hydrocarbons are not present in groundwater and that TPH concentrations detected are all within the diesel-range components. The extent of the dissolved TPH groundwater plume and areas of free product measured during January and February 2002 are shown on Figure 8-4. During the

[2] Assumed porosity is based on reports that levee is constructed with very large boulders and pore space is filled with typical aquifer materials.

Supplemental RI, the maximum site-wide TPH concentration was 2.6 mg/L (in 2A-W-6 on rail yard property). However, groundwater samples were not collected from within the LNAPL plume where there are typically elevated concentrations of dissolved TPH.

The highest dissolved concentrations do not correlate fully with the LNAPL plume boundaries. For example, groundwater from 5-W-2 contained 1.2 mg/L diesel-range TPH, and measured 0.32 foot of product during gauging, whereas the groundwater sample from 2A-W-6 contained 2.6 mg/L diesel-range TPH, yet did not contain any free product during gauging. Well 2A-W-6 did have residual product in the smear zone, which is probably the source of the high TPH concentrations.

The volume of dissolved product within the Site has been estimated using the supplemental RI data. The area of the dissolved TPH-diesel plume (depicted by the green dashed lines in Figure 8-4 is approximately 515,000 square feet. This calculation was made assuming an average TPH-diesel concentration of 0.5 mg/L, 30 percent porosity and an impacted saturated thickness of 15 feet, it is estimated that 30 gallons of TPH-diesel are dissolved in groundwater at the site.

The volumetric flow rate of dissolved product entering the Skykomish River has also been estimated using data collected for the Supplemental RI. The calculation uses the following assumptions that were made using data presented in the Supplemental RI report: the average hydraulic conductivity is 60 feet per day, contaminated groundwater flows through 400 feet of bank, the petroleum-contamination groundwater flows through five vertical feet of the sand and gravel aquifer (a silt unit prevents further vertical spreading of groundwater close to the river), the groundwater table declines by 0.027 feet for every horizontal foot close to the river, and the average concentration of dissolved petroleum hydrocarbons = 0.75 mg/l. Using these assumptions, approximately 0.018 gallons of petroleum hydrocarbons are calculated to flow into the Skykomish River per day. Note, the WTPH-Dx analysis can overestimate dissolved TPH concentrations because it may detect and quantify biomass in addition to petroleum compounds.

PAHs

Groundwater samples from 31 wells (and four Ecology splits) were analyzed for PAHs using EPA Method 8270-SIM during the Supplemental RI in January 2002. These wells were selected to be representative of a range of conditions and to provide good aerial coverage of the PAH concentrations. Figure 8-5 and Table 8-2 present the results of the PAH analyses.

The data show that the following PAHs were detected in one or more groundwater samples: acenaphthene, acenaphthylene, anthracene, chrysene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene. Acenaphthene and fluorene are the most commonly detected PAHs in the groundwater samples. Monitoring well MW-11 had the highest concentrations of acenaphthene (4.6 µg/L), acenaphthylene (0.64 µg/L), anthracene (0.53 µg/L), fluorene (7.2 µg/L), naphthalene (8.7 µg/L), and phenanthrene (8.2 µg/L). The following PAHs were included in the PAH analyses but were not detected in any of the sampled wells: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene.

PAHs were detected throughout the rail yard and more than 300 feet from the Skykomish River. Higher concentrations (defined here as greater than 10 times the reporting limit) of PAHs were detected in 2A-W-1, 2A-W-3, 2A-W-6, 2A-W-9 and MW-11. The groundwater samples from these wells, and others that contained several PAHs, generally contained dissolved TPH concentrations greater than 0.5 mg/L. MW-9 was the only well that contained PAHs and had less than 0.5 mg/L TPH; MW-9 only contained low concentrations of acenaphthene and fluorene near the reporting limit of 0.10 mg/L.

The PAH data show that the composition of the hydrocarbons varies throughout the site. There is a difference between the dissolved PAH concentrations in the eastern and southern parts of the rail yard (around 2A-W-9, MW-11, and 2A-W-6) compared with the western part of the rail yard (around 2A-W-1, 5-W-2, and MW-26). The eastern and southern parts of the rail yard contain a greater number of PAHs. Where PAHs were detected, acenaphthene and fluorene are present throughout the rail yard; however, the remaining detected PAHs are only present in the eastern and southern wells (with the exception of a low concentration, 0.03 µg/L, of pyrene in 5-W-2). The same trend is true if only PAH concentrations greater than 10 times the reporting limit are examined; in this case, fluorene is present throughout the site whereas the remaining PAHs (naphthalene, phenanthrene and acenaphthene) are only present in the southern and eastern part of the site. This dissolved PAH data corroborates some of the findings presented in the Draft RI Report, which documented different physical properties of the product in the vicinity of MW-39 compared to the product farther to the north. The Draft RI Report concluded that the specific gravity of the product at MW-39 is greater than the rest of the samples and the viscosity is an order of magnitude higher than the other values. In addition, the product from MW-39 contains approximately 21 percent diesel-range hydrocarbons compared to up to 49 percent diesel-range hydrocarbons in the LNAPL farther to the north.

In summary, the distribution of PAHs in groundwater has the following characteristics:

1) PAH occurrences are closely related to areas with LNAPL on the rail yard.

2) PAHs are not found within 300 feet of the Skykomish River.

3) Fluorene is the most widely distributed PAH.

4) There appear to be two types of oil associated with the former maintenance and fueling facility with different compositions and physical characteristics. The dissolved hydrocarbons in the western part of the rail yard contain elevated concentrations of fluorene and low concentrations of acenaphthene whereas the dissolved hydrocarbons in the southern and eastern parts of the rail yard contain several additional PAHs.

BTEX

Groundwater samples from 31 wells were submitted for analysis of BTEX using EPA Method 8020 during the Supplemental RI. These are the same representative wells that were analyzed for PAHs. BTEX would be the most pervasive VOC associated with TPH. The results of the BTEX analyses are summarized in Table 8-3. The BTEX components were below the detection limits in all samples except for toluene (1.80 µg/L) in MW-11. This is consistent with the BTEX results presented in the Draft RI Report in which the highest concentrations of toluene, ethylbenzene, and xylenes were noted only in MW-11 (1, 5, and 22 µg/L, respectively). These Supplemental RI results confirm that VOCs are not significant contaminants associated with the former maintenance and fueling facility.

EPH/VPH

Groundwater samples from 18 wells were submitted for analysis of EPH/VPH using the Washington State MTCA EPH/VPH Method during the Supplemental RI. Split samples were collected by Ecology from three of the wells, and a sample was collected from one well (2A-W-6) by Ecology only. The EPH/VPH results are presented in Table 8-4.

The EPH/VPH data show that extractable petroleum hydrocarbons were detected in outside rail yard well 2A-W-6 (0.3 mg/L) and volatile petroleum hydrocarbons were detected in rail yard well 2A-W-9 (0.2 mg/L) during the Supplemental RI sampling. The data show that the detected hydrocarbons, both volatile and extractable, are in the carbon range C10 to C34. Further examination reveals that there may be a difference in composition of the petroleum hydrocarbons found in the east and west part of the former maintenance and fueling. The two wells containing EPH/VPH on the east part of the rail yard (2A-W-6 and 2A-W-9) contain hydrocarbons with the range C10 to C16. The more western wells (MW-8, MW-25, and MW-36), analyzed prior to the Supplemental RI, contain hydrocarbons in the range C10 to C34. A similar difference in the chemical profiles was observed in the PAH data discussed above.

As reported in the 1996 Draft RI Report, the types of product used or stored at the railyard historically included bunker C, diesel, gasoline, fortnite oil and waste oil. Fueling operations were conducted with diesel and bunker C. The carbon ranges measured by the EPH/VPH analyses are consistent with the types of product historically used at the site. Diesel #1 contains hydrocarbons ranging from C8-C17, with the majority in the C10-C-14 range (TPH Criteria Working Group, 1998). Diesel #2 contains hydrocarbons ranging from C8-C26, with the majority in the C10-C20 range (TPH Criteria Working Group, 1998). These ranges for diesel are consistent with the EPH/VPH results for the east part of the railyard. Fuel oils, including bunker C are typically composed of hydrocarbons in the C20-25 range, up to C40. Furthermore, bunker C is usually blended with lower molecular weight fractions, such as diesel, to decrease viscosity and improve flow characteristics. Therefore, the carbon range for fuel oils can widen to as low as C6 with blending (TPH Criteria Working Group, 1998). Again, these ranges are consistent with the historic use of bunker C blended with diesel at the site, and the EPH/VPH results for the western area.

The variation in hydrocarbon composition between the east and west parts of the site could be due to one or more of the following four reasons:

1) Two different sources (releases) of oil – i.e., diesel in the east and bunker C in the west portions of the rail yard;

2) .Similar releases on the east and west portions of the rail yard from C10 to C16 hydrocarbons (diesel) and a more localized, separate release of the heavier C16 to C34 hydrocarbons (bunker C);

3) Similar releases on the east and west portions of the rail yard but different hydrocarbon migration characteristics; or

4) Similar releases on the east and west portions of the rail yard but different degradation rates or processes which selectively act on different hydrocarbon fractions.

8.2 PCBs

Groundwater samples from 13 wells were analyzed for PCBs during the initial RI fieldwork. The 13 wells were selected based on PCB detections in soils or proximity to possible areas of concern. No PCBs were detected in any of these wells during the initial RI investigation. However, prior to the initial RI fieldwork, PCBs were detected in well MW-32 at a concentration of 0.11 µg/L. Therefore, during the Supplemental RI investigation, groundwater from well MW-32 was analyzed for PCB. PCBs were not detected in MW-32 during the Supplemental RI (Table 8-5).

8.3 General Groundwater Chemistry

The pH, turbidity, conductivity, dissolved oxygen (DO) concentration, oxidation-reduction potential (ORP), and temperature of groundwater were measured in the field during the groundwater sampling event. These general chemistry data are summarized in Table 8-6. The pH varied from 5.02 to 6.47 standard units, the conductivity generally ranged from 37 to 268 micro-ohms per centimeter, and the temperature varied between 2.8 and 8.6 degrees Celsius; these are all within the typical ranges in groundwater. DO concentrations were collected from selected wells throughout the Supplemental RI study area. DO was not detected throughout much of the site; however, the following wells did contain DO: 1C-W-2 (2.73 mg/L), 2A-W-7 (1.5 mg/L), 2A-W-10 (0.55 mg/L), 2A-W-11 (0.2 mg/L), MW-1 (5.38 mg/L), and MW-44 (2.08 mg/L). The detected concentrations are all within the typical range for uncontaminated groundwater and, with the exception of MW-44 (east of the barrier wall), are all contained in wells upgradient from the detected contamination. The wells within areas of known contamination, and hydraulically downgradient from these areas (with the exception of MW-44) do not contain dissolved oxygen. The ORP (redox potential) varied throughout the area from -197 to 197. Low redox values can indicate anaerobic or anoxic conditions often seen in contaminated groundwater. The lowest redox values are generally present in wells in the vicinity of the rail yard. The lowest redox value is contained in 2A-W-3 (-197) on the rail yard. Higher values are present in the Area 4 and 5 wells, with the highest value in MW-44. The groundwater turbidity was measured from all wells sampled for the Supplemental RI; however, the data collected before January 18, 2002 are not presented because these readings were collected with a faulty instrument. The remaining measurements indicate that the turbidity varies between 1.7 and 20.5 Nephelometric Turbidity Units; these are typical values for monitoring wells.